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Summary of Awarded Presentation **1P42**

Maintenance of temporal attention in rapid serial visual presentation

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During the identification of a target embedded in a rapid serial visual presentation sequence, observers frequently miss a target when it appears early in the sequence as compared to when it appears later. This phenomenon, called *attentional awakening*, reflects a gradual modulation of temporal attention for a rapid sequence. In this study, we inserted a temporal gap (0, 100, 500, or 1000 ms) in the sequence and measured the critical conditions that destroyed the modulated state of temporal attention. The results showed that the correct identifications of the target were impaired immediately after the 1000-ms gap (Experiments 1). However, this impairment was eliminated by superimposing a continuous sequence of random dots so that the sequences temporally separated by the gap could be encapsulated as a single event (Experiment 2). These findings suggested that the temporally modulated attention could be maintained within a single event.

Key words: temporal attention, attentional awakening, rapid serial visual presentation

Attentional awakening refers to a phenomenon by which the accuracy in identification of a target is reduced when it appears early in a rapid serial visual presentation (RSVP) sequence but is recovered as the target appears later (Ariga & Yokosawa, 2008). This phenomenon appears to reflect a gradual modulation of temporal attention for a rapid sequence. In this study, we examine the duration of maintenance of the once-modulated attention after the sequence. Although it is expected that a temporally modulated state of attention would decay over time, as has been observed in other attentional effects, such as the inhibition of return or attentional capture, the temporal characteristics of attentional modulation in attentional awaking are unclear. In Experiment 1, we insert a temporal gap of various lengths in the sequence and examined the sequence to determine the length of gap that destroys the modulated attention. We focus on the accuracy in the identification of the target after the temporal gap, i.e., we observed the occurrence of attentional awakening after the gap.

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Experiment 1

Method. An RSVP stream of letters (one white target and some light-blue distractors) was presented at a rate of 10 letters/s. In the sequence, a target could be presented either between the 2nd and 10th frames or between the 13th and 21st frames. The sequence was terminated when a letter immediately following the target was presented. After the termination of the sequence, a probe (black dot) appeared at a location situated slightly to the left/right of the center of the display. The probe location was reported by the observers as quickly and accurately as possible and then the target letter was reported.

A blank interval (*Gap*: 0, 100, 500, or 1000 ms) was inserted between the 11th and 12th frames in the sequence when the target was presented in the 13th or subsequent frames. To improve the analyses, every three sequential target positions were integrated in order as a factor of *Bin*. In particular, the identification scores for the target positions 2–4 were collapsed as the 1st *Bin*, those for the target positions 5–7 were collapsed as the 2nd *Bin*, etc., for a total of six *Bins*. The experiment consisted of 648 trials.

Results and Discussion. The percentages of cor-

Table 1
Mean percentage of correct identification of the target letter.

	Gap (ms)	Bin 1	2	3	4	5	6
Experiment 1 (N=16)	0	59	58	63	69	64	65
	100				65	61	64
	500				63	65	66
	1000				56	64	67
Experiment 2 (N=20)	0	62	65	68	71	66	69
	100				71	66	66
	500				70	66	66
	1000				66	63	67

rect target identification are shown in Table 1. A one-way ANOVA conducted on the scores in the pre gap Bins (1–3) reveals a significant effect ($F(2, 30)=5.01$, $p<.05$). The post-hoc tests (Ryan's method) show significantly lower correct identifications for the 1st and 2nd Bins as compared to those for the 3rd Bin; this indicates the attentional awakening in the pre-gap sequence. A two-way ANOVA conducted on the scores in the post-gap Bin reveals a significant interaction between the Gaps (0, 100, 500, and 1000 ms) and Bins (4–6) ($F(6, 90)=2.60$, $p<.05$); this indicates that the identifications for the 4th Bin are lower that those for the subsequent Bins under the 1000-ms gap conditions. This result indicates the occurrence of attentional awakening after the temporal gap of 1000 ms. The effects of interactions between the Gaps and Bins on the probe localization accuracy were not significant.

The results of Experiment 1 suggest that the visual system is capable of maintaining the once-modulated attention for least 500 ms after the sequence, but it is incapable of maintaining the attention for 1000 ms.

Experiment 2

According to Sheppard et al. (2002), there are events at two hierarchical levels—global and local levels—in the RSVP sequence. The entire RSVP sequence can be considered as a global event, whereas the constituent individual item can be considered as a local event. The results of Experiment 1 demonstrate that when the global event is split by the 1000-ms gap, the temporally modulated attention cannot be maintained. In Experiment 2, we investigated the possibility for the modulated attention to be maintained as long as the global event exists behind the letter sequence, although it is task-irrelevant.

The procedure was the same as that in Experiment 1, except that the random-black-dots patterns were sequentially presented behind the letter sequence and also during the gap. The presentation of the random dots was synchronized with that of the letters.

The results are shown in Table 1. Similar to Experiment 1, we obtained attentional awakening in the pre-gap sequence ($F(2, 38)=6.45$, $p<.005$). However, no attentional awakening occurred in the post-gap sequence under any gap condition ($F(6, 114)=0.38$, *ns.*). Further, the probe localization accuracy was not affected by the Gap. The temporally modulated attention was maintained even through the 1000-ms gap by superimposing the letter sequence on the continuous sequence of random dots.

General Discussion

In this study, we determined three challenges regarding the maintenance of temporal attention in the RSVP sequence: (i) the temporally modulated attention could be endogenously maintained for at least 500 ms after the sequence; (ii) the results show the maintenance of a task-specific attention rather than the maintenance of arousal or vigilance; the performance of the probe localization was independent of that of the letter identification; and (iii) the modulated attention could be maintained even through the 1000-ms gap by superimposing the letter sequence on the continuous random-dots sequence. These results suggest that the temporally modulated attention is maintained within a single event.

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